

21. (New) The process according to claim 1 wherein the lignocellulose-based, hexose-rich material is treated by steam explosion and posthydrolysis.

22. (New) The process according to claim 1 comprising extracting the lignocellulose-based, hexose-rich material to form an extracted solution, fermenting the extracted solution to convert xylose into xylitol, chromatographically separating and crystallizing the xylitol solution to form an extracted mass, hydrolyzing the extracted mass, fermenting said extracted mass and recovering the resulting ethanol.

REMARKS

Prior to issuance of a first Official Action, consideration of the subject patent application in view of the preceding amendments and accompanying remarks, which have been made to place this application in condition for allowance, is respectfully requested.

Claims 1, 3-13, 15-16 and 19-20 are pending in the present application, and claims 21-22 have been added by amendment herewith. Support for the newly presented claims, and the amendment of claims 19-20 to clarify the hydrolysis process exists in the specification, for example, at page 4, lines 33-34, page 5, line 19, page 9, lines 4-13, as well as in Examples 6-9. Independent claim 1 has also been amended to particularly specify a lignocellulose-based, hexose-rich material and that a majority of starting material is processed, as also supported by the specification, for example, at page 3, lines 27-28 and page 4, lines 20-23. Support also exists in the examples, in particular, Example 2.

In the final Official Action dated September 16, 1996 for parent application serial no. 07/910,133 (now abandoned), the specification was objected to under 35 U.S.C. § 112, first paragraph, as allegedly failing to provide support for the hydrolysis of claims 19-20.

Similarly, claims 19-20 were rejected under 35 U.S.C. § 112, first paragraph, for the reasons set forth in the objection to the specification (Action, page 2).

In the interest of advancing the prosecution of the application, Applicants have amended claims 19-20 and added claim 21 to further clarify the hydrolysis process of the present invention. For example, Applicants' hydrolysis process may comprise a mild prehydrolysis, such as steam explosion, and a main hydrolysis step. The main hydrolysis step may be a two-step process, comprising for instance, an extensive acid hydrolysis with a strong acid followed by a mild hydrolysis with a milder acid or a milder enzymatic treatment. Treatment by hydrolysis or steam explosion and posthydrolysis is described at page 4, last paragraph, of Applicants' specification. Acid and/or enzyme hydrolysis is also described at page 5, second paragraph, and hydrolysis as a pretreatment operation is further described at page 5, last paragraph. Moreover, two-step hydrolysis and pretreatment-posthydrolysis are mentioned at page 6, first and last paragraphs, respectively.

Referring now to the examples set forth in the present specification, Example 1 includes mild prehydrolysis and enzymatic hydrolysis. Examples 4-5 include mild prehydrolysis and extensive acid hydrolysis. Examples 6-9 include the alternative route of partial (steam explosion) hydrolysis and extraction followed by final hydrolysis, as described at page 9.

It is respectfully asserted that claims 19-20 are fully supported by the specification, as described above. Accordingly, withdrawal of this objection and rejection under 35 U.S.C. § 112, first paragraph, is believed to be warranted.

Claim 11 was then rejected under 35 U.S.C. § 112, second paragraph, as improperly depending from a canceled claim (Action, page 3).

Applicants have amended claim 11 to depend directly from claim 22, and thus this

rejection should also be withdrawn.

Claims 1, 3-13, 15-16 and 19-20 were then rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,081,026 to Heikkila et al. (equivalent to WO 90/08193) (hereafter "the '026 patent"). These claims were also rejected under 35 U.S.C. § 103 as being rendered obvious by the '026 patent. Similarly, these claims were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of the '026 patent (Action, pages 3-5). The Examiner contends, in part, that the "amount of hexoses being small in the process of Heikkila et al, does not make the claimed invention unobvious since the claims do not require a larger amount..." (Action, page 4).

It is respectfully asserted that the presently claimed invention is neither disclosed in, nor rendered obvious by, the '026 patent for the following reasons.

Applicants initially point out that independent claim 1 has been amended to specify a lignocellulose-based, hexose-rich material and that a majority of starting material is processed, to further illustrate the distinctions between the present invention and the teachings of the '026 patent.

The '026 patent is cited in Applicants specification at page 3, lines 4-13. As described therein, the '026 patent is directed to a process for the production of pure crystalline xylitol from plant material using chromatographic separation following hydrolysis and fermentation. However, in this process the majority of the raw material is lost as a worthless waste material. If a greater part of the raw material could be converted to commercial products, this would essentially improve the economy of the overall process.

Applicants have developed a process which overcomes this problem, the details and advantages of which are set forth in the specification. For example, Applicants have developed a process in which xylitol and ethanol can be produced simultaneously.

According to Applicants' process, xylose is converted to xylitol, while the majority of the other hexoses present in the raw material are converted to ethanol. Thus, the raw material is effectively utilized and two commercially significant products are obtained in pure form and with a high yield (Specification, page 3, lines 24-32).

Moreover, laborious and complex separation steps (such as the conventional ion exchange, demineralization, precipitations, etc.) are not needed as a result of the present invention. Generally, the xylitol can be purified in a single step chromatographically, whereafter it is crystallized to obtain pure xylitol. Ethanol is easy to remove from the fermentation solution, for example, by evaporation. Thus, the need for separating xylitol from the hexitols and other sugars produced in the hydrolysis and reduction steps is avoided. The hydrolysis performed in accordance with the present invention also provides a solution to the problem of pulp discarded as waste mass in other processes, and thus in Applicants' process, substantially the entire starting material is utilized (Specification, page 4, lines 9-23). Such an advantageous process is not disclosed in, nor rendered obvious by, the '026 patent.

To further demonstrate the afore-described differences, Applicants set forth below three major areas of distinction between the present invention and the teachings of the '026 patent:

I. Raw Materials and Utilization thereof

In the '026 patent, the raw material has a high xylose content and a low hexose content. See, for example, column 2, line 47 and lines 63-66 which disclose a "xylose-containing material" and a "method for the production of substantially pure xylitol from an aqueous xylose solution which may also contain hexoses such as glucose as well as other *impurities*" (emphasis added). Moreover, the examples of the '026 patent clearly

demonstrate xylose as the main component and that the glucose content is much lower than that of the present invention. For instance, in Example 2 of the '026 patent, the ratio of xylose to glucose is 21.1.

Moreover, according to the teachings of the '026 patent, the hydrolysis and other processing of the raw material aim at obtaining a solution having a xylose content as large as possible, with the other components being present as impurities. Hence, even when the xylose content is efficiently utilized, the rest of the raw material remains unused and is lost as a worthless waste material.

In contrast, according to the present invention the "worthless waste material" can be utilized by Applicants' heavier processing of raw material, which leads to the efficient utilization of both xylan/xylose and glucose (*see*, for instance, Applicants' Example 1, the ratio of xylose to glucose is 0.75). Accordingly, hexose-containing lignocellulose materials can be utilized in addition to xylan-containing hemicellulose materials. Thus, according to Applicants' invention, the range of useable raw materials is extensive as compared to that of the '026 patent.

Furthermore, the contents of raw materials are much more efficiently utilized than those of the '026 patent because the carbohydrate content can be extensively hydrolyzed into hexoses and pentoses, both monosaccharide groups being desired as intermediates for the final products, xylitol and ethanol.

II. The Process Steps

The raw material in the '026 patent is processed to utilize a xylose-rich solution. In practice, when choosing birch wood, for example, the xylose content of which is high, a mild prehydrolysis results in a hemicellulose-based prehydrolyzate which contains a large amount of xylose, a low amount of hexoses and small amounts of other components. This

prehydrolyzate can be further processed by posthydrolysis, for instance, to hydrolyze all oligosaccharides possibly present to monosaccharides, or fermented directly, whereafter the xylitol produced is recovered. However, in this process the main part of the product obtained after prehydrolysis, i.e. the solid residue, is not processed at all, but discarded.

In the present invention, the raw material is used to a much greater extent, as described above. The raw material can be, for example, the solid residue obtained and discarded in the '026 patent, which is extracted and then extensively hydrolyzed, or it can be a biomass from softwood or hardwood, among others, which is hydrolyzed with acid and/or enzymatically. The hydrolysis conditions aim at utilizing most of the raw material. This is accomplished by using, for example, more severe hydrolysis conditions than that of the '026 patent, so that a total or extensive hydrolysis of the raw material is achieved. The differences in the process conditions are evident from the examples.

III. The Products

In the '026 patent, xylitol is produced. However, the main part of the raw material is not used and is discarded.

In contrast to the '026 patent and in accordance with the present invention, both xylitol and ethanol are produced in commercially useful amounts and the main part of the raw material is used for the production of these two products. Surprisingly, according to the present invention, it has been shown that xylitol can be produced in an economical manner when the xylan/xylose content of the raw material is low (in addition to producing ethanol).

In further support of Applicants' assertion that the '026 patent does not disclose nor suggest Applicants' presently claimed invention, a Declaration Under 37 C.F.R. § 1.132 Of Heikki Heikkila is also submitted herewith further expanding upon the above-mentioned distinctions between the present invention and the '026 patent.

In view of the foregoing, it is asserted that the '026 patent neither discloses nor suggests the presently claimed invention and the present application is, therefore, believed to be in condition for allowance. Accordingly, a Notice of Allowance is respectfully requested. The Examiner is invited to contact the undersigned attorney at 212-425-7200 should he have any questions or wish to discuss this matter.

No fees are believed to be due upon the filing of this preliminary amendment. However, should it be determined that a fee is required, the Commissioner is hereby authorized to charge our deposit account no. 11-0600 for the fee.

Respectfully submitted,

By: Donna M. Praiss
Donna M. Praiss
Reg. No. 34,232

July 8, 1999

KENYON & KENYON
One Broadway
New York, NY 10004
(212) 425-7200

82224